

Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Information Technologies



Bachelor Thesis

An integrated electronic timetable for an
university: analysis and prototype

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BACHELOR THESIS ASSIGNMENT

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Systems Engineering and Informatics
Informatics

Thesis title

An integrated electronic timetable for an university: analysis and prototype

Objectives of thesis

The goal of this thesis is to analyse and create a prototype of an integrated timetable serving as a web application to all relevant stakeholders at CULS.

The partial goals of the thesis are:

- To describe AS-IS and TO-BE states of the current electronic timetable at the university and conduct a requirement analysis.
- To select an appropriate prototyping method.
- To design a new integrated electronic timetable for the university as a set of low-fidelity wireframes.
- To assess the chosen prototyping method and formulate conclusions.

Methodology

In the literature review, a study of relevant professional and scholar literature will be done. The current state of the university electronic timetable will be analysed and an optimal prototyping method will be selected. Based on acquired knowledge AS-IS and TO-BE states of the electronic timetable and its processes will be described. In the practical part, by synthesising the findings, a low-fidelity prototype of the application will be developed. The selected prototyping method will be assessed in comparison with other methods and final conclusions will be formulated.

The proposed extent of the thesis

30-40 pages

Keywords

User requirements, prototype, timetable, schedule, calendar, testing, database.

Recommended information sources

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KRUG, Steve. Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability (Voices That Matter). 2014.

Expected date of thesis defence

2019/20 SS – FEM

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Declaration

I declare that I have worked on my bachelor thesis titled "An integrated electronic timetable for an university: analysis and prototype" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on March 12, 2020

Anastasiya Li

Acknowledgement

I would like to thank my thesis supervisor, Mr. Miloš Ulman, for his consideration, assistance and instructions during my work on this thesis; my family and friends, for their support, patience and encouragement during my studies and work on this thesis.

An integrated electronic timetable for an university: analysis and prototype

Abstract

This Bachelor Thesis deals with analysis and design of prototype for integrated Personal timetable application. In theoretical part, user experience and main development methodologies are defined in general terms. Furthermore, difference between wireframes and prototypes, their fidelities are explained as well. Most popular prototyping tools are described and compared by particular aspects. In practical part, AS-IS and TO-BE analysis is applied to set out current state of mentioned application. Present thesis shows how prototype that meets user wants and needs can be created, on the basis of wireframes testing and requirements collection methods.

Keywords: User requirements, prototype, timetable, schedule, calendar, testing, database.

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Chapter 1

Introduction

One of the most costly and irreversible resources is time. Time is money and time is life, therefore, it is important to wisely manage it. Life pace of modern person is not relaxing and measured. Sometimes it could be challenging to handle personal efficiency due to time shortage and amount of work to be done. Emotional strain makes it difficult to stay productive and leads to quick fatigue and apathy. People who devote time for planning, achieve more success. Daily planning is essential for enhancing productivity and effective time management.

We are living in rapidly changing world with constantly developing technologies. Electronic integrations should consequently progress and move forward for better life.

Nowadays, every university has its Information System (UIS) with automated processes in various areas including personal timetable. For example, at the Czech University of Life Sciences Prague it was identified, most students use paper printed PDF course schedule given by Study Office, Student's Portal HTML table or photo saved on smartphone gallery. To organize study time, it is not convenient and does not comply with rapidly evolving Information Technology industry. Information System needs continuous improvement which is efficient practice for quality assurance. According to contemporary level of IT development, it is indispensable to bring in advanced technical capabilities and get on with more innovative applications.

This work is focused on analysis and design of personal timetable from university information system which is intended for both students and academic staff. Web application prototype will be created following development lifecycle steps and analysis

of user requirements. It shall display schedule as interactive calendar, including regular classes, study blocks, exams and changes in timetable. Assumed to have maintenance administrators to provide up-to-date information.

Moreover, web applications are accessible from any electronic devices such as PCs, laptops, tablets and smartphones using web browser. On top of that, it does not require additional memory space, only working Internet connection is required. Future implementation implies synchronizing schedule via URL subscription on Apple (iCal) and Google calendars.

Chapter 2

Objectives and Methodology

2.1 Objectives

The goal of this thesis is to analyse and prototype an integrated timetable serving as a web application to all relevant stakeholders of CULS. Since it involves environment with multiple actors, i.e. students and academic staff, interface will look slightly different depending on user. Suggested solution will arrange effective data sharing and demonstrate that schedule may be not only plane list of times and events but also interactive application with most recent content.

The partial goals of the thesis are:

To begin, an overview of the relevant literature regarding web application development life cycle, user requirement analysis, important aspects of wireframes and prototypes will be made. It will cover requirement gathering techniques, prototyping process and methods review.

Another point is to make an analysis of the current electronic timetable at the university and recommendations for improvement. Present solution will be specified applying AS-IS study and TO-BE requirements. User needs will be obtained in accordance with studied bibliography.

Lastly, a prototype following the identified user requirements and integrated system architecture will be designed and proposed. iCalendar subscription will be prepared for prospective transfer to timetable application.

2.2 Methodology

The bachelor thesis is focused on following sections: literature review, research, practical part and discussion of results. In the literature review, the study of relevant professional information sources will be done. Based on acquired knowledge, assessment of prototyping tools will be done by weighing their pros and cons. AS-IS and TO-BE states will be used to define the current state of electronic timetable. By synthesising findings, an optimal prototyping method will be selected. In the practical part of the work, low-fidelity wireframe will be performed considering its features. Proposed prototype of application will be further evaluated using SWOT matrix and final conclusions will be formulated.

Chapter 3

Literature Review

3.1 User Experience

Individuals represent core of experience, hence must be taken into consideration in design of systems. But even the most intelligent person in the best physical shape has limitations of human beings which should be contemplated by technological innovations and progress. (ROSENZWEIG, 2015)

User Experience is about how product is used in real life and how it reacts. During product's development process, designers pay full attention to what it does. Conversely, User Experience is focused on how product works which can distinguish product's success from failure. It refers to how product performs 'outside', when person interacts and uses it; not how it operates 'inside' (despite its high importance at times). However, User Experience is formed from every product that someone uses. Little things are essential and can even result in company's loss of client, regardless of what a product or service is. (GARRETT, 2010)

In the World Wide Web, User Experience is especially vital comparing to other products. Websites nearly always are 'self-serving tools'. User can rely only on his personal experience and knowledge – no manuals, no teaching tutorials, no support service – to figure out how a site is functioning. Even though User Experience has a major influence for website success, unfairly low priority was given to simply understand users' wants and needs for almost entire history of Web. Generally, it was supposed that launch of a website is huge achievement, and user friendliness went to the background in the best cases. Adding newer content and expanding functional capabilities confused newcomers in Web. Meanwhile many organizations overlooked what real customers prefer, what they value and what they indeed can use. Nowadays, companies started to understand that high quality of User Experience is fundamental and long-lasting benefit in competition. User Experience is literally the one that creates user's perception of

products and services, recognizes the difference between company and its competitors, and defines if user returns to a site. (GARRETT, 2010)

Design thinking, human-centered design (HCI) and user-centered design (UCD) are key user-oriented branches which are fundamental for User Experience. At first sight, all of them seem identical, sharing similar actions and common topics, when in fact final results are not same. These principles have infinite process implying that product's User Experience is at no time completed. It is continuous repetitive cycle to determine proper method for product. (RITTER & WINTERBOTTOM, 2017)

3.2 Development Methodologies

It is essential to know methodology - general approach to application's implementation. Choice of a proper approach is affected by many factors including team's structure and location, involved technology and extent of cooperative work as a part of corporate culture. This section will compare 2 standard types and 3rd type that displays possible modifications during development process. Note that most of methodologies comprise the same phases:

1. Requirements Formulation
2. Planning Process
3. Application Development (front-end, back-end)
4. Release

Phases' names may differ; however, primary types of activities are common at every stage of following approaches. (UNGER & CHANDLER, 2012)

3.2.1 Waterfall

Classic waterfall development methodology is well organized process that was derived from production and construction sectors. Furthermore, it costs a lot to amend design at the time of subsequent phases of a process.

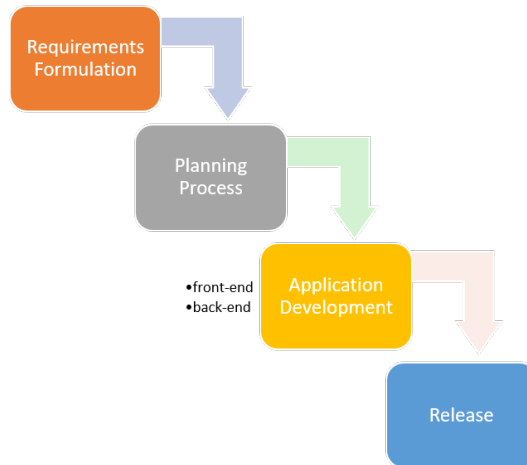


Figure 3.1: Waterfall: Sequential development

Source: Own processing according to (UNGER & CHANDLER, 2012)

In waterfall development approach each phase flows to next, namely it is considered as separate step while each following stage begins only after approval of previous one. One of the negative sides of 'pure' waterfall methodology is that completion of each following stage requires little changes in results of preceding. (UNGER & CHANDLER, 2012)

3.2.2 Agile

Agile application development approach is a repetitive, team-oriented and step-by-step methodology. It is more progressive on the premise of changes incorporation. Using agile, process is separated into controllable stages; thereby team concentrates on each phase thoroughly. Agile approach respects users' comments and makes it possible to regularly improve, providing for their requirements and feedback of team.

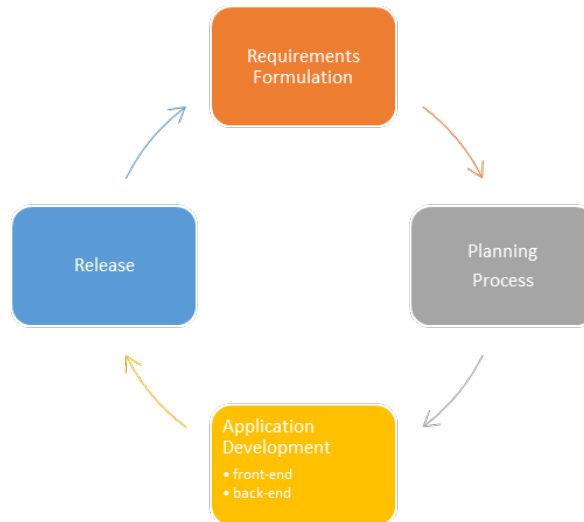


Figure 3.2: Agile: Repetitive and step-by-step development

Source: Own processing according to (UNGER & CHANDLER, 2012)

Many methodologies use more flexible and faster approach - when some phases implemented in parallel – than waterfall model. Agile methodologies are usually more oriented on cooperative work and requires less detailed documentation and formal claims. 'Real' agile approaches assume small sized teams' participation where members are geographically close to each other and pay minimum attention to definition of formal positions in a team. It provides high level of collaboration which decreases need in detailed results documentation between planning, development and testing phases. Nonetheless, majority of companies and projects rarely adopt 'pure' agile methodology. More often they use services of distributed teams and remote workers, causing complication in close cooperation. On the other hand, distributed agile approach can be done with spread of virtual collaboration tools and digital sketching tools while teams work hard on clear communication, high availability and effective decision-making. (UNGER & CHANDLER, 2012)

3.2.3 Modified

Applying aspects of both waterfall and agile methodologies, combines the best features of both 'worlds': from one side – structure and documentation that reduces risks of distributed teams and constantly changing participating members; and from the other side – collaborative work and iterative way to ensure sufficiently operational reaction on changes. Tools such as wireframes and prototypes provide feedback in quick repeating elaboration of ideas before development phase. (UNGER & CHANDLER, 2012)

Nielsen Norman Group’s study on best practices of UX methodology project integrations shows that agile achieves more success than waterfall methodology. In year of 2009 specialists assessed waterfall having greater progress than in agile environment; after 7 years model has visibly changed. Research indicates that for requirements formulation and planning process can be applied waterfall, while for release phase - agile. (LORANGER & LAUBHEIMER, 2017)

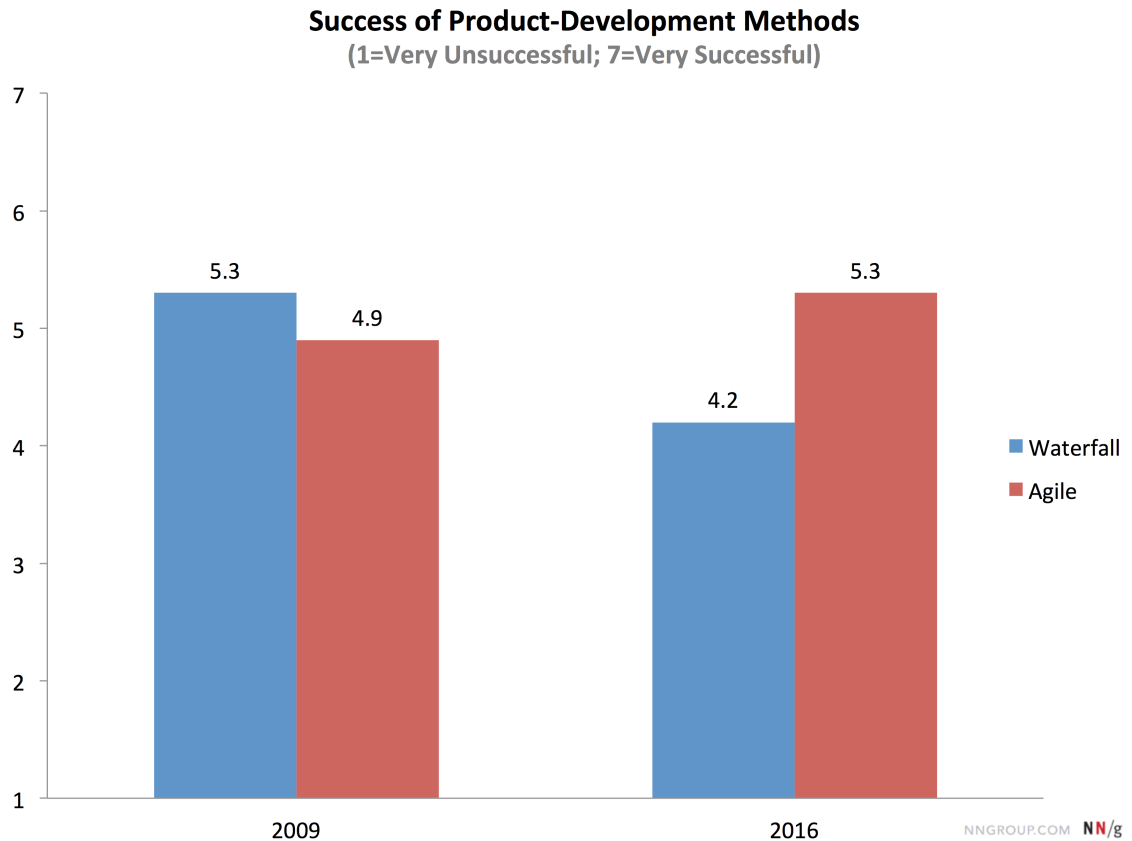


Figure 3.3: Development methods’ success comparison

Source: Nielsen Norman Group

3.3 User requirements collection methods

It is not exactly true that user requirements collection takes long time and big money. There are events that comply with any time constraints and financial resources – some can be managed in two hours whereas others can take months. Each type presents different information and has diverse purposes. There exist user requirements collection methods that can meet any schedule and funding. Each of them defines its part of end user. Some methods “can be intensive in time and resources (depending on

design) but provide a very rich and comprehensive data set. Others are quick and low-cost and provide the answers almost immediately.” Furthermore, each of these methods can offer various data to help in product or service development. (BAXTER *et al.*, 2015)

There are plenty of user requirements collection methods that can be applied within entire development lifecycle. They are used to better know potential users, as well as to test how they will behave on various site releases. In the following sections most common requirements collection methods will be described in detail. (UNGER & CHANDLER, 2012)

3.3.1 Diary Study

Diary study expects users to describe their actions, routines, feelings, attitudes throughout a day. Huge sample’s in situ, long-term data can be gathered by a researcher. There are diaries in paper or electronic format, structured – when given certain list of questions or probes, or unstructured – when users have free report form. Presence of a researcher is not necessary to obtain quantitative and qualitative data. Interviews, or other requirements collection methods are usually performed together with diary studies. It is appropriate to conduct for defined questionnaire with simple questions that will not be regular and not take much users’ time to complete. Traditional diary studies were implemented with pen and paper. These days, advantages and disadvantages turn up with diversity of formats. It gives users freedom in expression and expands data selection. In this way, with easier input, better quality data can be gained.

- *Paper*

In paper format, users are supplied with a guide, forwarding address, postage-paid envelope and parcel that can consist of a brochure with blanks to fill in. Moreover, user can be requested to take photos for experience visualisation and send by email or upload them to cloud account.

- *E-mail*

Nowadays, almost everyone has an email account (except some developing countries). Email format requires users to send emails with records, visited website links, photos, videos, etc. from time to time. They can occasionally receive notice emails with extra questions or probes to respond.

- *Voice*

Voice recordings expressing emotions result in providing richer experience. However, it can be challenging to recognise feelings - is it anger, delight, etc. and to make transcription if user has accent or records not in quiet place. He can besides record audio messages using smartphone and email them.

- *Video Diary Study*

Since most people have smartphones, tablets, laptops and PCs with built-in webcams, video diaries can be appealing for both users and researchers. In case of not having any electronic device, researcher can borrow web camera or cheap cell phone with videotaping feature. Considering users' video platform preferences, it is essential to choose the most widely common.

- *SMS (Text Message)*

Young users will be attracted to SMS/text messaging method in comparison to other written conversation. Researcher should create account to receive messages with reports.

- *Social Media*

Nearly all users spend noticeable time in social media. Therefore, real-time data can be collected through say, Google+, Facebook, Twitter etc.

- *Online Diary Study Services or Mobile Apps*

Online Diary and Mobile App tools have been designed with various capabilities such as embedding with social networks, sending audio and video entries. Data collection can be observed with properties of web user interfaces. (BAXTER *et al.*, 2015)

3.3.2 Interview

Interviews represent a well-structured communication with current or potential users. They can be done by phone, video conferencing software, as private meetings on neutral ground (e.g. conference hall) or, at best, in user's typical interacting conditions. Interviews assist to learn about choices and perspectives of users, although it is not possible to make statistical conclusion in efficiency of user's interaction with website or application. Statistical methods of data analysis about website visiting can also provide information regarding efficiency of website that ensures background for data interpretation. (UNGER & CHANDLER, 2012)

3.3.3 Survey

During large audience survey, it is proposed to response prepared list of clearly formulated questions. Generally, they should be closed, i.e. with constrained set of answers (e.g. questions with one selection in multiple choice). To compile results, programs analyse patterns in obtained outcomes. Survey fits best in situations when output should have numerical form unlike in interview's open questions. Nevertheless, it allows to get quantitative as well as qualitative information about habits and views of users. Surveys are frequently conducted for evaluation of users' satisfaction with actual website or application, and to develop or test user models e.g. segments and personas. (UNGER & CHANDLER, 2012)

In survey, same questions are asked to users in well-organized form. They can finish it during their free time at work or when leisure at home. Surveys can be spread worldwide among larger amount of participants and get larger sample sizes in short term than from interviews and focus groups. Share of respondents fluctuates between 1% of charity surveys and 95% of census surveys. Web surveys are widely used these days, while paper and telephone surveys can propose special features. (BAXTER *et al.*, 2015)

3.3.4 Brainstorming (Wants and Needs Analysis)

Wants and Needs Analysis includes asking users' requirements on content types, aspects and properties of product. This application of brainstorming does its work for any product or service and creates list of preferential wants and needs of multiple users. Method can be used for monitoring current plan of characteristics along with studying new aspects considered as important and beneficial for users. It can be implemented anytime, while demonstrating the best results at conceptual product development stage. Wants and Needs Analysis can be done in approximately an hour and relatively less time-consuming in analysis of its outcome which makes this method light on resources but powerful regards to data. Although brainstorming with users is fundamental in W&N Analysis, it is more beneficial together with analysis than by itself - involving prioritization step enables to define the most significant wants and needs from all shared ideas and avoid feature-creep (potential to eventually add more and more features). (COURAGE & BAXTER, 2005)

3.3.5 Focus Group

In focus group, five to ten (perfectly six to eight) users are gathered for an hour or two to answer set of questions from expert facilitator or propose subjective view

for product ideas and presentations. Generally, participants should go through tasks with product prototypes in order to better express their perspectives. Group discussion triggers by providing questions or product and can give more details than one-on-one interview. Focus groups are applied to various situations including research in social sciences (since 1930s) and marketing. It is one of methods to use when information about target audience is limited, though is better for creating concepts than making official assessment and review. Focus groups cannot be used to summarize participants' opinions – except disproving or approving ones. Issues, difficulties, troubles, dissatisfactions, preferences still can be revealed from users. This method can come up with large supply of helpful information in short time when conducted in a right way. Participants of focus groups are more often enthusiastic and motivated to talk about their experiences in informal and natural environment and use preferred way of communication with group of same age than individually with interviewer. To the contrary, disadvantage of focus groups is in the fact participants are more likely to be influenced by public and agree with sufficiently influential group representatives. (BAXTER *et al.*, 2015)

Focus groups help in dealing with following objectives:

- **Collection of various user stories.** Free discussion helps people to find themselves as narrators. If conversation in focus groups goes well, people mutually complete stories and ideas while also think back on situations that usually do not come to mind during formal individual interviews. Format and vibe of group discussion assists people to recall and share them with other people.
- **Study differences in user perception.** In most cases, people are willing to share information as well as talk about their favourite effective tools in groups with common interests. In conversation, it is often possible to gain information about competing websites and services or catch useful suggestions regarding workaround solutions, resources and support techniques.
- **Generating ideas.** Focus group does not take place of designer but often allows to hear impressive ideas about new functions or looks for user interface – directly from group participants or within discussion of workflow or frustration sources. It is necessary to get to original requirements and take care of meeting them.
- **Understanding of interaction points in collaborative processes.** If designed process is based on multiple roles and their cooperation, focus groups will help to fill gaps in views of interaction between people. When working with content project, it is beneficial to include content makers, editors and users to detect areas where processes can be improved. (UNGER & CHANDLER, 2012)

3.4 Wireframes vs. Prototypes

Detailed architecture designs of buildings is roughly the same as wireframes for software. They illustrate structure of functional pages. Wireframes show which elements appear on page and how they correlate with each other. Generally, they are implemented in black and white or shades of grey. Wireframes in combination with detailed description of elements' behavior work more effectively than requirements documents alone. However, remaining gaps cause omission of details or wrong interpretation. Prototype is a model or simulation representing final system draft. As compared with requirements documents and wireframes, it provides an opportunity to test design. (WARFEL, 2009)

Selection of fidelity level is essential for prototyping and significantly impacts on final results of testing. Fidelity denotes how precisely prototype appears and behaves as final product. Suitable fidelity level will concentrate obtained feedback on possible feature of design, hence fidelity choice is based on goal of prototype. There are different levels of fidelity – low, mid and high, and also mixed. Prototyping procedure typically delivers good effect starting from low-fidelity and gradually raising fidelity level to the point while majority of assumptions are reviewed and, validated or corrected. More prototypes are created on early stage of process and less when idea turns into more subtle. It is vital to be able to deal with changes and determine in process fidelity that is accurate for each tested concept. If fidelity level is overly high, user will deliberately consider design as 'complete' and will provide feedback only to refine some parts rather than evaluate general ideas. If fidelity level is overly low, user may not likely to make sense of context and lose in proximities. Moreover, there is a balance between time and effort required for creating prototype and worth gained from testing at that particular level. By deciding on appropriate fidelity or making mixed fidelity (depends on stage of development process) and objective of prototype, enables to use less time and receive accurate feedback for enhancing ideas. (MCELROY, 2017)

3.4.1 Low-fidelity

Start prototyping with low-fidelity is a best practice with a view to consider general ideas before entering to particular path. Information architecture (IA), that is to say, arrangement and labels of interface, is subject to be elaborated at vast level. IA and wireframes may serve as formulation to real, interactive prototypes. Apart from organization, IA also identifies terminology that might be best comprehended by user. Wireframes make it simpler to imagine how IA can be transformed to interface. It is important to test both prior to proceeding with more interactive methods. Moreover,

there are paper and clickable prototypes of low-fidelity that are not hard to create and do not take plenty of skills or time. If paper or sticky notes are available at hand, it is possible to craft basic interface for testing. It can be used for advanced negotiations of broad concepts. While prototypes of mid- to high-fidelity may be provided to business stakeholders and development teams. (MCELROY, 2017)

3.4.2 Mid-fidelity

Mid-fidelity prototypes enable to examine exact matters, describe vision, better cooperate with stakeholders and are great deal for both time and quality. It is quite natural to smoothly move back and forth through low-, mid- and high-fidelity prototypes. On many occasions, designers develop low-fidelity prototypes to look at whole problem and ways to solve it and subsequently proceed with mid-fidelity prototype and test previously arisen assumptions. There are few distinct perspectives when prototype can be addressed as mid-fidelity on the premise of what has been created before and access to content. Fidelity level can be increased relying on what better facilitates goal of testing or collaboration. In early stage of process, should be tested how user navigates all over the product or sufficiently performs certain task. Clickable prototypes are introduced to achieve that interaction level. They should provide authentic data with intuitive terminology for users. At later stages, for more interactive environment, it has its merits to write coded prototype or use advanced software to make required interactions. (MCELROY, 2017)

3.4.3 High-fidelity

Once most of assumptions has been assessed by means of prototyping and user testing, major problems have been dealt successfully, high-fidelity prototype can be developed to merge all acquired knowledge and design. When there are no coding skills or available developers' assistance, by creating clickable high-fidelity prototype it can be done look like functional, coded one. Optimal practice is to use graphics editor, e.g. Adobe Illustrator or Sketch to clearly portray products' appearance; and prototyping software, e.g. InVision, Flinto or Axure RP to involve interactions and lively animations. Prototype implementation should include all way product experience – high precision of visual design, actual user data and content (not only images but also written material), any flows or animations, and interactions. Whole system and back-end may not be there since it is prototype for now, however, the rest must replicate prospective resulting product. At this stage of process, instant specifics and interactions are tested – if font size is flexible to different sizes of displays, animations complement

experience and do not prevent user concentration, content is reader-friendly and action queries are explicit and available. It is necessary to search any problems user encounters at time of testing which implies that language, action queries, navigation, task flow of user interface should be obvious and user knows his location in system. To meticulously test those parts which cause problems with high-fidelity prototype, it will be needed to modify corresponding interactions at mid-fidelity. It would do well to take a look at new tools which accelerate team work. (MCELROY, 2017)

3.5 Tools for prototyping

There are diverse prototyping tools and methods – some tools are well-known for a long time, large number of tools that came out in last few years and new ones appearing daily; their landscape is changing rapidly. In general, people sort tools in compliance with fidelity of made prototype which provides a good basis for start, nevertheless, it is more efficient to look at tools from the perspective of more than one category. (COLEMAN & GOODWIN, 2017)

Design Fidelity

Various levels of fidelity can be seen as spectrum from fast-track prototypes in the form of sketch up to full-fidelity prototypes in the form of wireframe with application of color palettes, typography and other design features. There are couple of factors that can complicate categorization of prototyping tools according to fidelity. Besides visual design quality, prototype fidelity covers complexity level, realism and scope, and/or prototype's content deepness and introduced navigation, and to what extent user interfaces are implemented (richness and deepness of interactions, and if transitions and animations are shown). Fidelity can be easily combined and mixed up with complexity, difficulty and speed of prototype creation. Commonly, it is faster and simpler to manage tools that create elementary prototypes in the form of sketch; in fact, several more complicated tools that require more time to learn thoroughly, yet create only prototypes of wireframe-level fidelity. A number of tools are able to do their work on the entire fidelity spectrum. This primarily refers to tools that accept any kind of design document and allow to create prototype with it (e.g. InVision). This document can be sketch, basic wireframe or model with full-fidelity design, as well as HTML that may be used for plain layout or higher fidelity prototypes development. (COLEMAN & GOODWIN, 2017)

Tool	Hand sketch	Wireframe	Full-fidelity design
Paper	●	○	○
PDF	◐	◐	○
PowerPoint/ Keynote	◐	●	○
Balsamiq	◐	●	○
Axure RP	○	●	○
Adobe XD	○	●	●
HTML	○	●	●

Table 3.1: Prototyping tools mapping by Fidelity

from ○=not applicable to ●=fully applicable

Source: Own processing according to (COLEMAN & GOODWIN, 2017)

Tool Complexity and Speed of Use

Assessing how to operate prototyping tool without difficulties or problems, how much expert capabilities and proficiency must be trained to use tool, they can be divided into three groups:

- easy in use, simple to cope with and can create prototypes quite fast;
- complex, learning curve is steeper and typically take more time on prototype creation;
- sit somewhere in between.

It is not that easy to assign prototyping tools into categories. Learning curve, speed of prototype creation and complexity at times are connected or not. Learning curve of certain tools and methods is shallow since anyone can immediately and easily use them. Number of tools with steep learning curve require memorizing significant amount of information. However, as soon as they had been learned thoroughly, prototypes can be made at fast speed. Indeed, there are tools for those who are whether smoothly working from more technical, analytical or more design perspectives, or mixture of both. Selected prototyping tools are especially fitting quick, definite prototype creation where other tools and methods are used for designing, e.g. pen sketches on paper, Photoshop or Sketch. (COLEMAN & GOODWIN, 2017)

Tool	Easy/quick/ shallow	Medium	Hard/slow/ steep
Paper	◐	○	○
PDF	◑	◐	○
PowerPoint/ Keynote	◑	◑	○
Balsamiq	◑	◐	○
Axure RP	○	◐	●
Adobe XD	◑	◑	○
HTML	○	◑	●

Table 3.2: Prototyping tools mapping by Complexity and Speed of Use

from ○=not applicable to ●=fully applicable

Source: Own processing according to (COLEMAN & GOODWIN, 2017)

The Aim of Prototype

For accomplishment of various project goals prototyping tools can be classified into following categories:

- to quickly develop design ideas for interfaces and user flow, and thoroughly review them;
- to design and demonstrate basic organization and arrangement;
- to design and demonstrate more sophisticated content organization and/or long-term path with user participation. (COLEMAN & GOODWIN, 2017)

Tool	Quickly develop design ideas for interfaces and user flow, and thoroughly review them	Design and demonstrate basic organization and arrangement	Design and demonstrate more sophisticated content organization and/or long-term path with user participation
Paper	●	◐	○
PDF	●	◐	○
PowerPoint/ Keynote	●	◑	○
Balsamiq	●	◑	○
Axure RP	○	◑	●
Adobe XD	◐	●	◑
HTML	◐	●	●

Table 3.3: Prototyping tools mapping by Aim

from ○=not applicable to ●=fully applicable

Source: Own processing according to (COLEMAN & GOODWIN, 2017)

3.5.1 Paper Prototyping

Paper prototyping is action of creating prototypes from materials made of paper, cards, cardboards, notebooks, post-its, etc. what can be cut, folded, drawn on and turned into prototype. It might make final result of project better than before, and even spend less time and budget. This prototyping tool has the lowest entry level. Paper exploitation provides excellent possibility for early and frequent prototyping through design process. Paper prototyping at time of creative process may improve independent or collaborative ideas generation and their testing. It contributes to mutual understanding among clients and project team which allows them to get concept. In addition, designs may be reviewed by users for approval and refinement. (COLEMAN & GOODWIN, 2017)

Paper prototyping is the most flexible tool from existing. Paper is perfect for development of anything, from web interfaces to gesture interactions. Nowadays, paper prototyping is the most popular tool. Needless to say, paper and other analogue tools have their cons as any other tool but pros are greater:

- rapid, not expensive (mainly free) and simple;

- can be used at any time and any place, no need in computer;
- one of a handful tools convenient for teamwork. (WARFEL, 2009)

3.5.2 PDF

In addition to broad use of PDF, there are advantages including relatively reasonable and practical document sizes and, capacity in publishing and reading among various platforms. Many platforms and devices supply preinstalled software to read PDF, which is moreover, available for free. Nearly everyone is able to open file in PDF format, therefore, such prototypes are frequently used to present and share to members of project team and user research group, and stakeholders. Capacity to make documents with hyperlinks is a part of PDF standard. Designing interactive PDF prototype assumes that simple prototype can be developed while operating tool which provides creation of links across pages and exporting to PDF (e.g. Adobe InDesign, Balsamiq), or is able to make changes in existing PDF (Adobe Acrobat Pro, pdfforge).

More strengths:

- simple and affordable to design basic clickable prototypes while operating tools with ability to create PDFs;
- prototypes in spectrum of fidelities from sketches, through wireframes, up to highfidelity models can be developed;
- capacity to show and test prototypes on devices with touch screen and small width displays.

Weaknesses:

- workflow may be difficult to deal with and taking a long time, especially when PDF has not been exported and created yet;
- constraints in design of responsive/adaptive prototypes due to specific PDF scale capacity;
- hyperlinks across pages in PDFs support no more than narrow elementary operations. (COLEMAN & GOODWIN, 2017)

3.5.3 PowerPoint/Keynote

Microsoft PowerPoint and Apple Keynote are more than just applications for creating perfect presentations. They are not as good as Axure or HTML, but have started to

be popular tools for prototyping. Approximately in 40 per cent of cases, they are used in one or other form in prototyping industry. PowerPoint played significant role in interface design of Microsoft Corporation's Windows 7, Windows Live, Internet Explorer and Expression Blend. PowerPoint is installed on almost every office computer in the world, as well as Keynote. When customer or designer provides multiple Photoshop files and asks to develop prototype, they can be attached in Dreamweaver and image map can be made out of them, or PowerPoint/Keynote may be employed. They can be used to make narrative and interactive prototypes. Following are reasons why it is worthwhile to take advantage of PowerPoint or Keynote for prototyping:

- most likely, tool is available at hand;
- low learning curve;
- slides templates provide high consistency and efficiency;
- outcome can be exported to clickable PDF or HTML prototype; (WARFEL, 2009)
- essential properties for drawing and design (grid layout, guides and tools to position elements, simple import of images and other visual arts, simple publishing or sharing);
- spectrum of visual fidelity is right on point – not so sketchy or messy, not so refined and ready for production.

Disadvantages:

- display area is not flexible (with set of regular presentation slide scaling and ratio of width to height);
- not reliable in sizing and alignment elements on slides;
- must be taken into account what is being prototyped, how and where will it be shared and presented;
- none of responsive/adaptive designs are supported. (COLEMAN & GOODWIN, 2017)

3.5.4 Balsamiq

Balsamiq exists for years and many people will be familiar with its manipulation for creating wireframes. This tool rightfully gets good reputation on how simple it is

to begin with. Balsamiq is well-suited for making rapid low-fidelity prototypes in the sketch look. People creating their first wireframes can start to deal with its drag-and-drop interface without difficulties, even having insignificant experience in design and other design tools. Desktop application works on both Windows and Mac platforms. Furthermore, there is web version named myBalsamiq and other plugin versions (such as one which can be found on top of Google Drive for collaborative working). Balsamiq is interesting that aside from creation of basic wireframes, it offers ability to create interactive prototypes. Majority of design elements can be transformed to links and those links can link to other pages/screens. This functionality is sufficient to develop basic clickable prototypes. Balsamiq can be good tool for review and representation of prototype designs on early stages. It is characterized by minimal advanced design tools, instead of concentrating on straightforward drag-and-drop interface with vast set of pre-drawn symbols which able to work well on a larger scale. Such dependence on library of symbols implies that tool cannot be so capable for designing with original, non-standard elements of user interface.

Disadvantages:

- wireframe/sketch look and missing flexible design/drawing tools narrow designers to creation of basic low-fidelity prototypes;
- not likely to be a tool working well and producing good results on large prototype development from scratch;
- no concept of information architecture/website hierarchy, therefore prototyping and testing of website complete structure will require time and possibly be ineffective and prone to error;
- unable to prototype transitions and animation for user interface;
- incapacity of responsive/adaptive presentation – shared PDF will be displayed on different devices of different width, but it will not be exactly responsive prototype. (COLEMAN & GOODWIN, 2017)

3.5.5 Axure RP

Designers, especially those who work in User Experience, have been using Axure RP (Rapid Prototyping) to make diagrams, wireframes and prototypes for several years. It is extremely high-powered, flexible tool for design with number of features. With such capacity and flexibility goes high cost and likely steep learning curve. Just as in Balsamiq, layout design is accomplished mainly out of comprehensive library with

premade symbols, elements and icons. Interface is created by dragging-and-dropping and organizing them on canvas with aid of advanced kit of alignment, layout, and sizing guides and tools. Axure gets fully functional events model where each element may have events and event handlers added to it. Comprehensive set of actions is outside basic ability to link and go to other pages, as noted with other tools outlined. Axure RP is first tool which comes with features for developing prototypes that will work with different screen sizes. They are more adaptive than responsive and enable to specify alternative screen dimensions to initiate designs react differently when moving between them. Axure creates prototypes as HTML/CSS what makes them distributable and shareable. One of problems could be, for example, need to install Chrome extension to view HTML version. (COLEMAN & GOODWIN, 2017)

Axure makes it possible to use one tool for design as well as for documentation. Main advantage is ability to add annotations to projects, automatically generate documents with specifications and interactive prototype. (WARFEL, 2009)

3.5.6 Adobe XD

To make it easier for designers to produce websites and web applications designs, Adobe has developed new application. It is intended to substitute Adobe Fireworks which has been used throughout the years to design user interfaces. Adobe XD purpose is wider than of other tools since it covers prototype fidelity spectrum all the way up to full fidelity. This denotes it may likely be used through entire design process to delivery of production build assets. As with majority of tools, design and drawing toolkit contains efficient features which are well-known to many designers:

- artboards, layers and element group workflow that aid with organization of large design projects and their individual parts, such as pages or templates down to separate elements;
- tools which assist with rapid layout design comprise grids, positioning and spacing guidelines, and allocation of selected elements groups;
- making reusable symbols from groups of elements along with library of symbols for their organization.

Moreover, there are plenty of interesting features for building and sharing interactive prototypes, such as:

- Prototype view: allows to create links between artboards for templates and pages in designs, visualize and organize them;

- Prototype online sharing option: automatically publishes design to cloud for simple sharing with those who take part in project. As soon as published, prototypes may be shared with others via link and commented by reviewers;
- Real-time device preview: changes made in designs can be viewed on device in real-time, by installing Android or iOS application to mobile device and then connecting to desktop or laptop with launched Adobe XD using USB cable;
- Repeat grid: worthwhile feature that accepts design for element such as teaser block (teaser to article with image, title, synopsis and link to full article) and repeats it over horizontal or vertical grid.

Adobe XD demonstrates potential as high-powered tool for designing prototypes. At the moment, it has free access for anyone to download and attempt. Program seems to be user-centered, therefore there is opportunity to affect product design and its assortment of features. Despite the fact that designs are vector-based and scale across various display areas, features for supporting responsive/adaptive prototypes are missing. (COLEMAN & GOODWIN, 2017)

3.5.7 HTML

HTML prototypes can be different – from simplest slapped images to simulation of final product. The easiest way is to use HTML for slapping multiple images in JPG format and creating interactivity based on them. Operational HTML prototypes built from HTML code, e.g. those which Axure RP generates or by using Dreamweaver editor in WYSIWYG ('What You See Is What You Get') mode, cannot or should not be reused to create final version of product. There are also HTML prototypes of final product level – Holy Grail of prototyping. They are effective when manual HTML coding does not cause difficulties. CSS frameworks, in particular, Blueprint, 960 and YUI! coupled with popular JavaScript frameworks including jQuery, Prototype and YUI! (they have libraries for both CSS and JavaScript), have simplified HTML prototyping. It is worth to invest a little time studying HTML, CSS and basics of JavaScript to make real thing. HTML has a number of advantages making it valuable prototyping tool:

- much easier than it seems;
- plenty of available CSS and JavaScript frameworks which are useful for newcomers;
- free of charge;

- allows to estimate project's cost and chances of success;
- one of the few tools and methods that provides feature for collaborative work;
- offers opportunity to export generated code to operational version, significantly shortening product time to market. (WARFEL, 2009)

Chapter 4

Practical Part

This part of thesis will cover usability evaluation, establishment of current and expected states of timetable application, and gathering of user requirements. Appropriate tool will be selected and used to implement wireframe and prototype. Final product should accomplish indicated objectives, meet with usability heuristics and, user wants and needs. Research questions for practical part to focus on:

RQ01 What are the main principles to evaluate usability?

RQ02 What tasks to formulate for comparison of AS-IS and TO-BE states?

RQ03 What to take into account when selecting prototyping method?

4.1 State of the art

Objectives of timetable application:

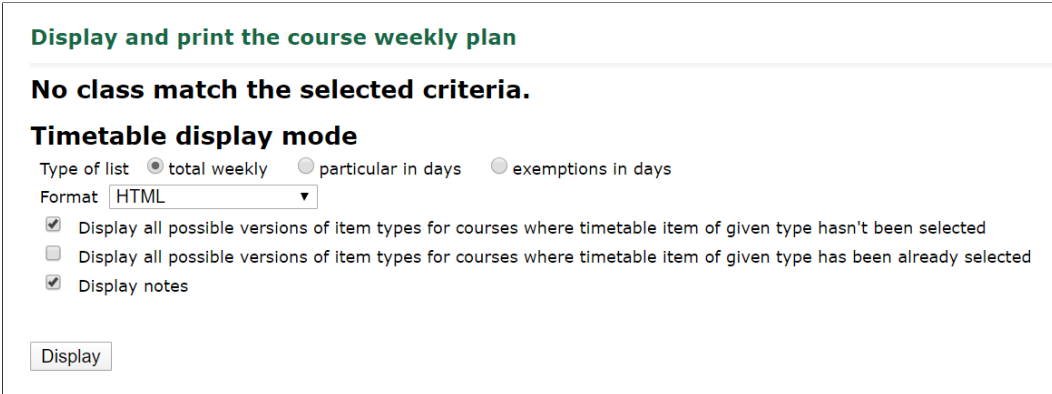
- design responsive web application;
- create interactive timetable with up-to-date information:
 - display timetable in different layouts,
 - filter out timetable items by entries,
 - notify about timetable adjustments;
- show properly start and end time of timetable entries;
- distinguish timetable items by colour;
- suggest transfer of iCalendar subscription.

4.1.1 Usability Heuristics

Heuristic evaluation is a usability engineering method for identifying the usability issues in a user interface design so that they can be taken as part of an iterative design process. Heuristic evaluation assumes having a small set of evaluators inspect the interface and estimate its compliance with recognised usability principles (the 'heuristics'). (NIELSEN, 1994b) The most basic of these principles are ten Usability Heuristics. (NIELSEN, 1994a)

1. *Visibility of system status*

Timetable does not expose which changes were made among timetable items. Message on non-meeting criteria is not immediately noticeable due to coalescence with main body.



The screenshot shows a web interface for displaying a course weekly plan. At the top, there is a green header with the text "Display and print the course weekly plan". Below this, a bold black message states "No class match the selected criteria." Underneath, the section "Timetable display mode" contains three radio buttons for "total weekly" (selected), "particular in days", and "exemptions in days". There is also a dropdown menu for "Format" set to "HTML". Three checkboxes are present: "Display all possible versions of item types for courses where timetable item of given type hasn't been selected" (checked), "Display all possible versions of item types for courses where timetable item of given type has been already selected" (unchecked), and "Display notes" (checked). A "Display" button is located at the bottom left of the form area.

Figure 4.1: Example of principle #1

Source: University information system CZU

2. *Match between system and the real world*

Timetable is displayed in rows with days of week and columns with time blocks. Under each item can be found detailed information on course code and name, room number and teacher.

3. *User control and freedom*

User is able to go back to previous pages with provided hierarchy of four levels higher than current page.

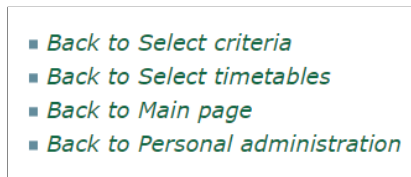


Figure 4.2: Example of principle #3

Source: University information system CZU

4. *Consistency and standards*

Application uses straightforward terminology, organisation and graphic design do not change across its pages.

5. *Error prevention*

Notice is shown after selection of non-meeting criteria. However, ‘Display’ button stays active what does not prevent user to click it repeatedly.

6. *Recognition rather than recall*

Exact start and end time are not specified, user should change display format to ‘List of timetable items’ to clarify them.

Day	08:45- 09:30	09:30- 10:15	10:30- 11:15	11:15- 12:00
Mon				
Tue	<div style="border: 1px dashed black; padding: 5px; background-color: #e0ffe0;"> PEF D326 / 3b-infoa ETE3AE Web Design ⁽¹⁾ P. Šimek </div>			

Figure 4.3: Example of principle #6.1

Source: University information system CZU

Note numbers assigned for timetable items should be kept in mind to see their meaning below timetable.

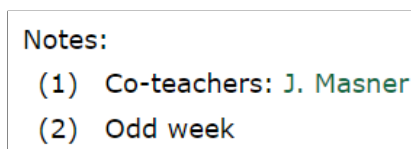


Figure 4.4: Example of principle #6.2

Source: University information system CZU

7. *Flexibility and efficiency of use*

Timetable is available in a few formats – ‘HTML’, ‘List of timetable items’, ‘PDF’, as well as specific display options – ‘total weekly’, ‘particular in days’, ‘exemptions in days’.

8. *Aesthetic and minimalist design*

Timetable items do not differ in colour by course code/name but by entry (lecture/seminar). Interpretations of key and notes clutter user interface design.

9. *Help users recognise, diagnose and recover from errors*

Shown notice of non-meeting criteria provides link ‘Back to Select criteria’ to choose fitting ones.

10. *Help and documentation*

Application guide can be found in the top right panel and is available in single language under question mark icon.

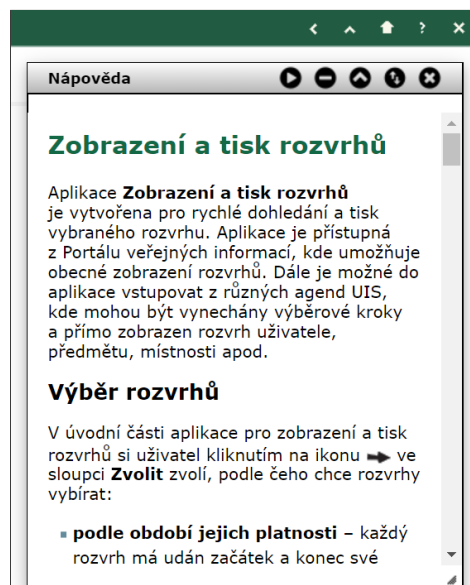


Figure 4.5: Example of principle #10

Source: University information system CZU

4.1.2 AS-IS/TO-BE

Before designing user interface for timetable application, AS-IS and TO-BE requirements were defined. For this purpose, five tasks derived from objectives set in Chapter 4.1, were developed. Current and expected scenarios were described for each task.

Task	Scenario	
	AS-IS	TO-BE
Display timetable for current week	Under ‘Timetable display mode’ section select ‘particular in days’ type of list, choose ‘since’ and ‘till’ date of current week, click ‘Display’ button.	Current week timetable will be displayed by default on ‘Personal timetable’ page.
Locate start and end time of class	Under ‘Timetable display mode’ section select ‘List of timetable items’ format, click ‘Display’ button. Find time interval below ‘From’ and ‘Until’ columns in generated table.	Time interval will be given directly in timetable item.
Learn about changes in timetable	N/A. To spot adjustments, timetable application should be attentively monitored.	Timetable adjustments will stand out through ‘Notifications’ feature.
Print timetable in PDF format	Under ‘Timetable display mode’ section select ‘PDF’ format, click ‘Display’ button.	Print feature will be available straight away from timetable application under respective button.
Get URL for iCal subscription	Proceed to ‘Back to Personal administration’ link at the bottom of page. Under ‘Personal management’ section click down arrow icon to disclose ‘Other applications’, follow ‘Export calendar to iCal’ link. Click ‘Export’ button to retrieve URL in ‘.ics’ format.	Feature to subscribe iCalendar will be accessible right from timetable application under respective button.

Table 4.1: AS-IS study and TO-BE requirements for current application

Source: Own processing

4.1.3 Definition of user requirements

Survey

Survey was conducted among six users of a given timetable application. Participants

were students from different study years and degree programs. Prepared multiple choice questions were distributed on paper where only one answer was allowed. Table with outcome for each of them is provided below.

Questions	Answers	Number of participants
How do you keep track of your classes?	paper printed PDF course schedule given by Study Office	1
	screenshot saved on smartphone gallery	4
	Student's Portal HTML table	1
How often do you visit UIS Personal timetable?	one-time	1
	weekly	3
	monthly	2
From which device do you usually access UIS Personal timetable?	smartphone	5
	tablet	0
	PC	1
How long have you been using Personal timetable application?	< 1 year	1
	1-2 years	1
	> 2 years	4
Are you aware of feature to "Export calendar to iCal"?	yes	1
	no	5
How are you satisfied with current Personal timetable application?	unsatisfied	2
	neutral	3
	satisfied	1

Table 4.2: Survey outcome

Source: Own processing

Brainstorming (Wants and Needs Analysis)

After completion of survey same six users proceeded to brainstorming session which took approximately two hours. During discussion, many topics were raised about present situation with timetable application. Five out of six highlighted that design

lacks flexibility and interactivity with user. This was supported with performance of notes represented as not communicative plane excerpt. In fact, small fraction did not have clue about superscript note numeration inside timetable items. Around half of participants put forward suggestion that instead of explanatory key under timetable, state entry in items themselves. There was also spoken about concept of changing color scheme to distinguish between individual regular classes. Large number of users pointed out that courses start and end hours are not accurately displayed in case of timetable item is not positioned within time block. Finally, issue of missing notifications on the most recent timetable adjustments was mentioned.

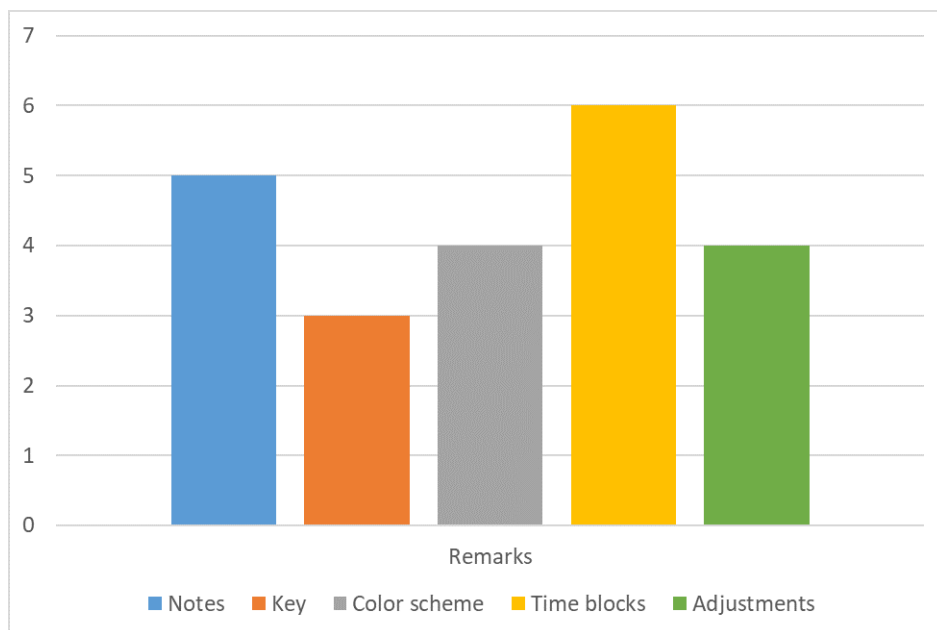


Figure 4.6: Share of remarks for refinement

Source: Own processing

4.2 Selection of tool

(Prototypr.io, n.d.) has developed resource to compare and analyse prototyping tools depending on needs such as speed, affordability, interactivity, fidelity, user testing, wireframing, collaborating, and export to code. Two of them can be selected and displayed on axis of matrix.

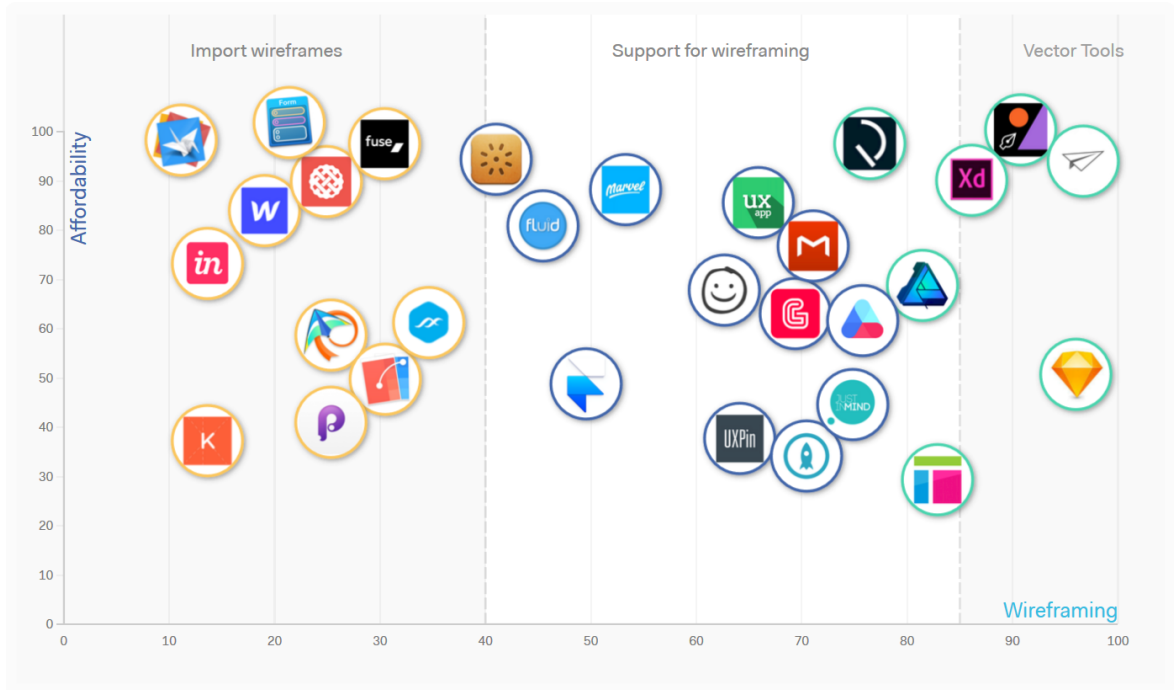


Figure 4.7: Prototyping tools matrix by Affordability and Wireframing

Source: (Prototypr.io, n.d.)

Adobe XD prototyping tool was selected for final design based on multiple aspects arising from list of books studied in Chapter 3.5. First of all, it must cover wide spectrum of fidelity. Adobe XD supports development of both wireframes and high-fidelity prototypes that are close to real product and ready for sharing with developers. Secondly, process of mastering software was intuitive and relatively fast. Another determining factor was that in Adobe XD, it is possible to design prototype with advanced interactions which could be further used in user testing. On the basis of matrix from Figure 4.7, the affordability of individual prototyping tools was evaluated. Paper prototyping is accessible to everyone for free but may require well-developed sketching skills. At the same time, for slightly higher than average price Balsamiq can present equivalent prototype in digital format with tidier look. The least budget-friendly tool turned out to be Axure RP which offers even lower fidelity than Adobe XD.

4.3 Implementation

Adobe XD prototyping tool was used to implement wireframe and mid-fidelity prototypes. There are three operational modes – design, prototype and share. Design mode allows to insert text, draw shapes including rectangles, ellipses, polygons and lines. Colours, character styles and components saved to assets panel may be modi-

fied and used across multiple artboards, making design process more efficient. Layers feature defines project organization as well as structure of individual screens. Great variety of available plugins can broaden design, usability testing and collaboration functionality, contributing to simplification of workflow. In prototype mode particular elements wire artboards using various interactions activated by tap, drag, keys or voice. It is possible to live preview project in progress on mobile devices with installed XD application and desktops. Share tab offers to publish prototype for review, deliver design specifications for development, refine for presentation or test with users (Figure 4.8). Complete project is later accessible at created link with/without require of password.

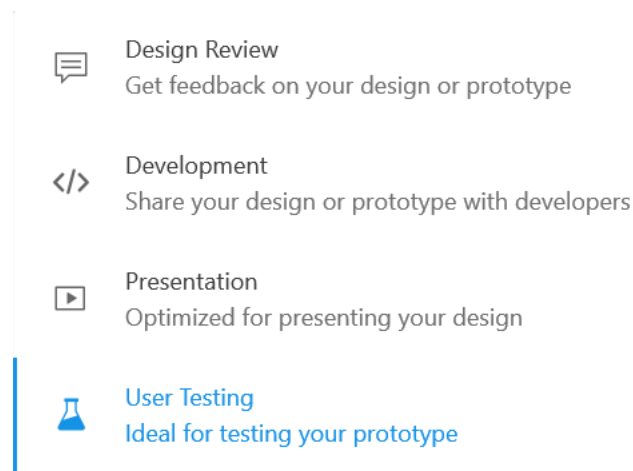


Figure 4.8: Sharing options

Source: Adobe XD

Functional wireframe was designed with help of ‘Quick Mockup’ plugin that provided essential elements (e.g. buttons, checkboxes, dropdowns, icons, images, etc.) for low-fidelity prototyping. After testing it with users who participated in requirements collection, received comments and remarks were taken into account and supported in introducing mid-fidelity prototype. It was created incorporating mobile devices and desktop screens to simulate responsive web design.

Proposed Personal timetable application shows week as five working days with seven time blocks referring to blocks of regular classes. Current academic year and semester are indicated above schedule. Goal of interactive calendar is achieved by adding ability to move across weeks, change week view (vertical and horizontal), show/hide particular timetable items which include days off (national holidays) and get notifications on changes in schedule. Print PDF and subscribe iCalendar options were embedded there as well.

Thanks to ‘Layers’ panel, it was simple to manage and maintain organized structure of prototype. ‘Line’ tool was used to depict main template of calendar. Timetable items were sketched with ‘Rectangle’ drawing shape. Teasers with days of week and time intervals were taken by ‘Repeat Grid’ feature to obtain required appearance. Color palette was established to distinguish entries by kind and stored in assets panel (Figure 4.9). For all text instances ‘Verdana’ character style was applied in various font sizes. ‘Icons 4 Design’ plugin supplied with suitable icons used in design and saved to components.

Transitions and auto-animate interactions throughout screens are accomplished by tapping or dragging assigned elements. On top of that, prototype for mobile devices performs overlay interaction sliding down the artboard.

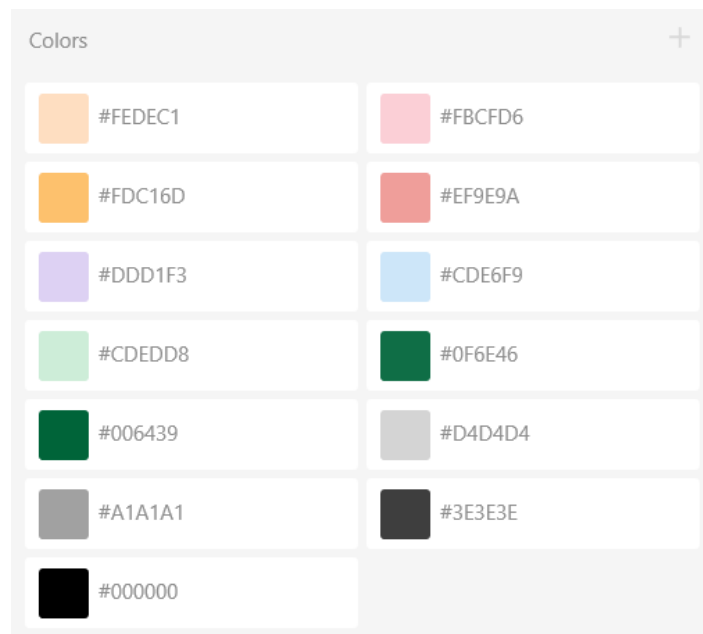


Figure 4.9: Color palette applied for mid-fidelity prototype

Source: Own processing

4.3.1 Wireframe

Wireframe for desktop screens represents user’s personal schedule as five days overview. Regular hours of classes appear in seven blocks with fifteen minutes breaks. Date interval of current week and week number (odd or even) are surrounded by arrow buttons allowing to switch across previous and following weeks. Present day is highlighted with bold frame. Icons displayed on right side are timetable week views (vertical and horizontal), filters, notifications, print and subscription. View buttons have two states active (in dark color), i.e. clickable and inactive (in grey color). When

user is in horizontal view of week (Figure 4.10), corresponding icon becomes inactive; vertical view button is clickable and enables to turn into vertical view (Figure 4.11). If there is an adjustment in schedule, a number appears on notification button that expands respective details by clicking (Figure 4.12b). Timetable content is filtered by type (Figure 4.12a) – regular classes, study blocks, exams and consultation hours (for teaching personnel). It also includes standard print feature. Subscription button (Figure 4.12c) provides URL to sync schedule with iCal (Apple) or Google Calendar.

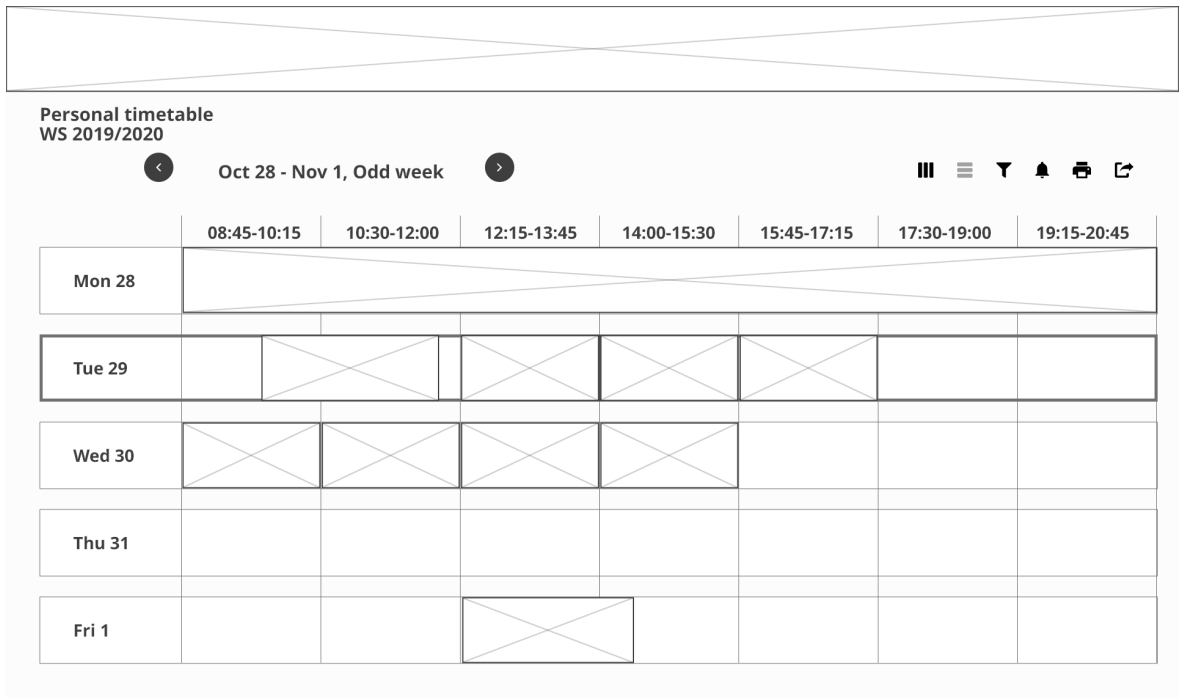


Figure 4.10: Wireframe: Horizontal week view

Source: Own processing

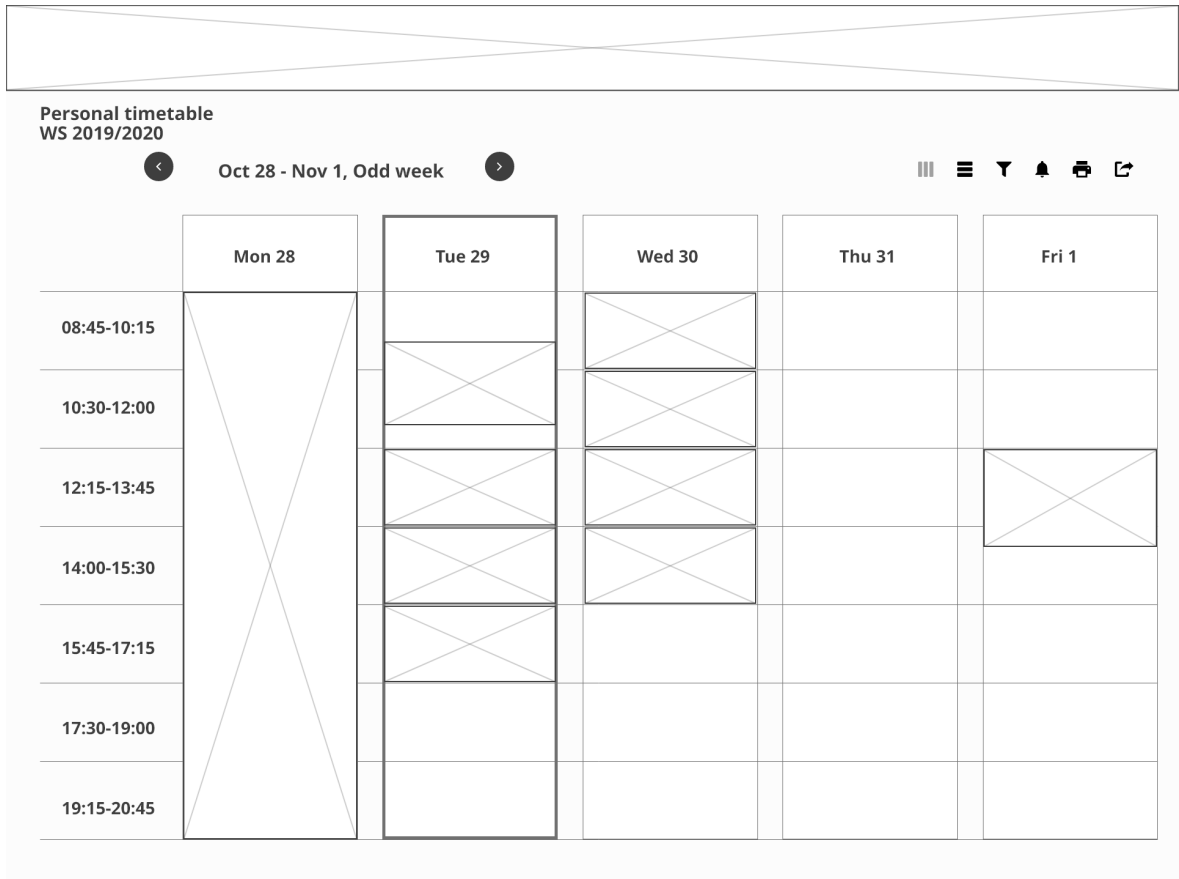
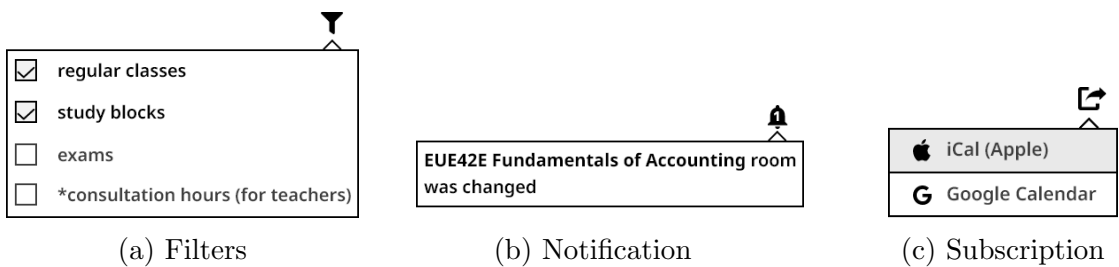


Figure 4.11: Wireframe: Vertical week view

Source: Own processing



(a) Filters

(b) Notification

(c) Subscription

Figure 4.12: Dropdown buttons

Source: Own processing

4.3.2 Mid-fidelity prototype

Desktop

For mid-fidelity desktop prototype eight artboards were created (Figure 4.13). Each of them demonstrates specific features and layouts for common cases of application. Particular buttons trigger transition or other interactions connecting home screen to

related artboards (Figure 4.14). Color palette was applied to distinguish regular classes, study blocks, exams and holidays. It is possible to take a look at them by clicking arrow icons designed to browse through weeks (Appendices B.6, B.7, B.8) and filter them out accordingly (Appendix B.3). Every course stands out by its color (for both lectures and seminars), while study blocks, exams and holidays have designated coloring. Ongoing day of week and day are marked with distinct font color and underlined. Sample timetable item consists of room number, course code and name, entry (lecture, seminar, study block or examination), start and end time. Timetable in vertical week view (Appendix B.2) may be transformed into horizontal week view (Appendix B.1) by clicking respective view button. Number of notifications can be seen on bell icon which discloses message about changes in schedule. Strong color of side border and font in timetable item indicate course and point up correction (Appendix B.4). Whole timetable is importable to iCal (Apple) and Google Calendar applications via link (Appendix B.5).

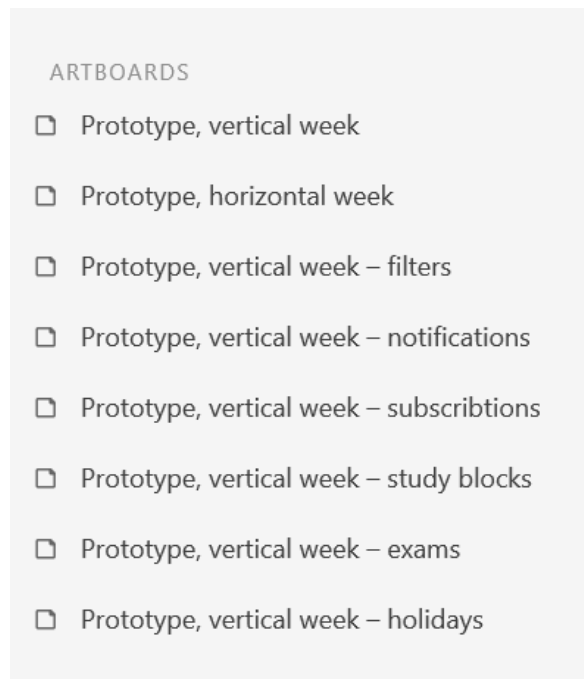


Figure 4.13: Desktop artboards

Source: Own processing

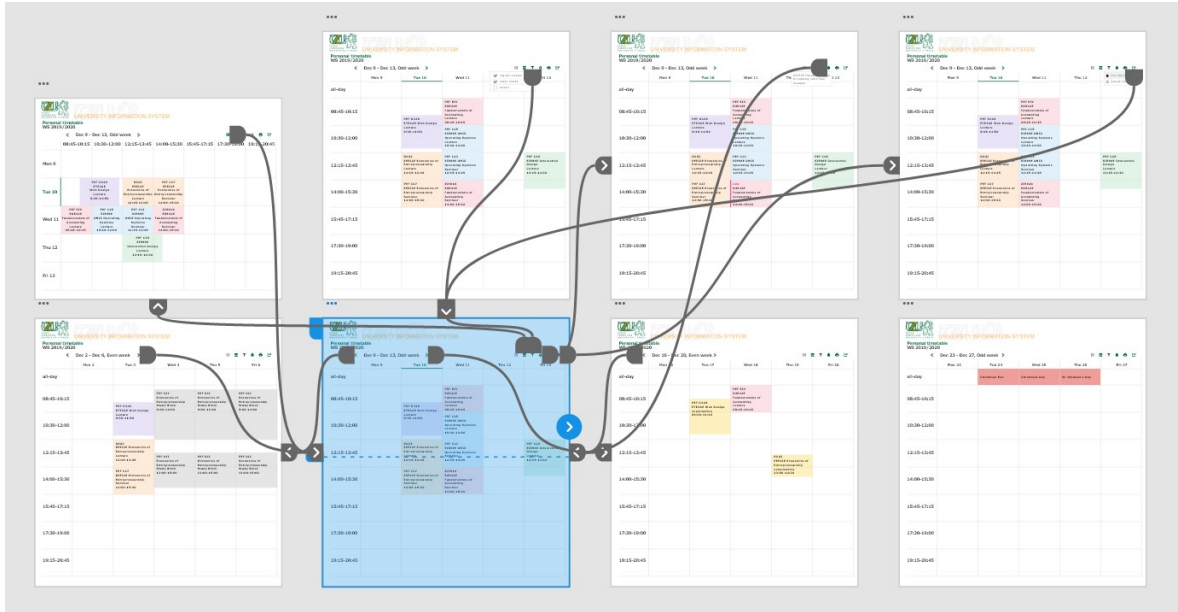


Figure 4.14: Interactions with home screen

Source: Own processing

Mobile devices

Prototype was designed for both portrait and landscape orientation of mobile screens. Portrait orientation artboards display one day and half of following day courses in vertical week view. When user swipes left or right to navigate entire week schedule, time interval blocks are pinned on side (Figure 4.15). There is information button that pop-ups with hint message to change view orientation (Figure 4.16a). Current week dates surrounded by arrows controlling move throughout weeks. Options bar is arranged of three icons – filters, notifications and subscription that can be activated on tap with overlay interaction (Figures 4.16b, 4.16c, 4.16d). Closing notification message leads to jump in day and course with change (Figure 4.17). Taking into account desktop prototype, feature buttons for vertical and horizontal week view, and print were eliminated from mobile prototype for practical reasons.

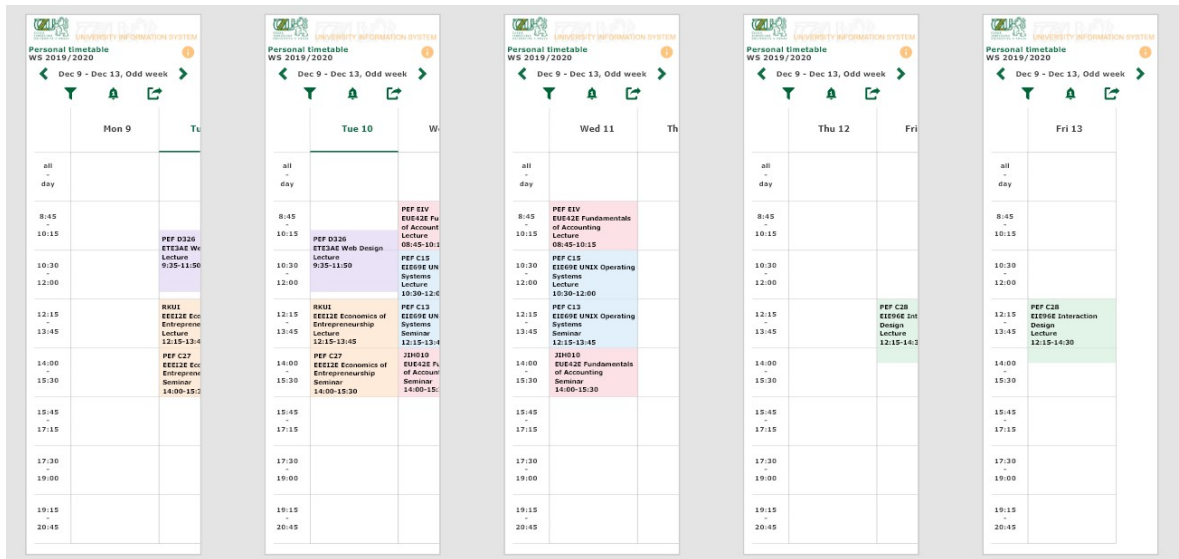
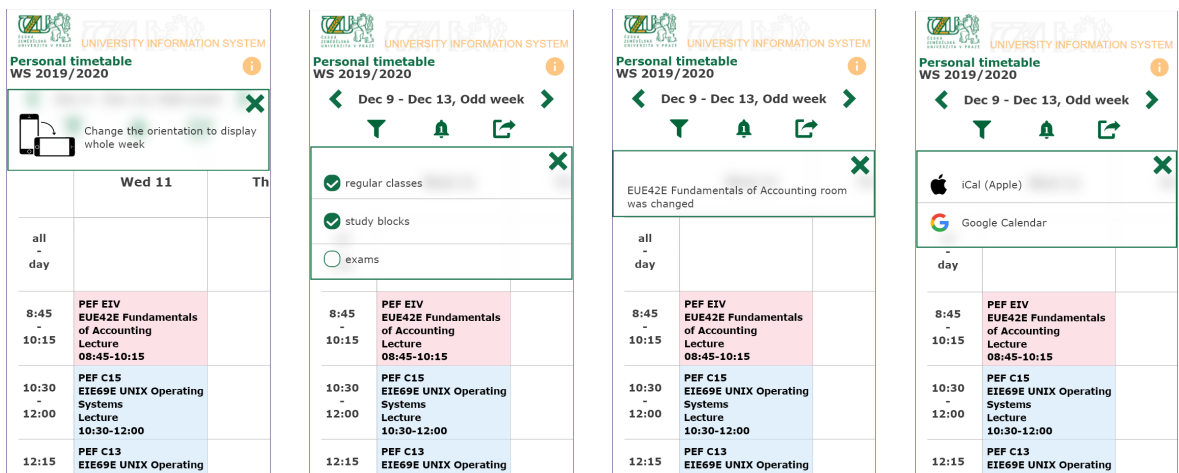


Figure 4.15: Portrait orientation artboards

Source: Own processing



(a) Information

(b) Filters

(c) Notifications

(d) Subscription

Figure 4.16: Artboards with overlay interaction

Source: Own processing

Personal timetable		UNIVERSITY INFORMATION SYSTEM	
WS 2019/2020			
◀ Dec 9 - Dec 13, Odd week ▶			
🔿 🔔 📧			
		Wed 11	Th
all - day			
8:45 - 10:15	PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30 - 12:00	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00		
12:15 - 13:45	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45		
14:00 - 15:30	C24 EUE42E Fundamentals of Accounting Seminar 14:00-15:30		
15:45 - 17:15			
17:30 - 19:00			
19:15 - 20:45			

Figure 4.17: Artboard with change in course

Source: Own processing

Prototype with landscape orientation offers to see whole week timetable at once (Appendix A.1). If user scrolls down, days of week names together with date stay fixed when reach top of screen. Other features except for information notice are derived from portrait orientation design.

Chapter 5

Results and Discussion

To make Web content more accessible, it should follow recommendations from Web Content Accessibility Guidelines (WCAG) 2.2. There are two Success Criteria from Guideline 1.4 Distinguishable in terms of contrast:

- Success Criterion 1.4.3 Contrast (Minimum) (Level AA): The visual appearance of text and background of text has a contrast ratio of at least 4.5:1;
- Success Criterion 1.4.6 Contrast (Enhanced) (Level AAA): The visual appearance of text and background of text has a contrast ratio of at least 7:1. (World Wide Web Consortium (W3C), 2020)

Following WCAG 2.2, EightShapes Contrast Grid tool was used to check contrast in blend of background and text colours. Existing design meets Level AAA (contrast ratio from 8.1:1 to 19.9:1), except for one combination complying with Contrast (Minimum) requirement, contrast ratio of 6:1. Alternatively, proposed design fulfils the Contrast (Enhanced) requirement for the entire colour palette with contrast ratio of 10:1 to 16.7:1.

Background \ Text	#0000FF	#000000
	#90EE90	Text AA 6
#E0FFFF	Text AAA 8.1	Text AAA 19.9

(a) existing design

Background \ Text	#000000
	#D4D4D4
#CDEDD8	Text AAA 16.7
#CDE6F9	Text AAA 16.2
#DDD1F3	Text AAA 14.4
#EF9E9A	Text AAA 10
#FBCFD6	Text AAA 15
#FEDEC1	Text AAA 16.4

(b) proposed design

Figure 5.1: Contrast test

Source: Own processing

5.1 SWOT analysis

SWOT analysis was used to weigh positive and negative sides of proposed prototype considering internal and external factors. SWOT abbreviation stands for **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats. By establishing priorities among quadrants, it clarified identification of future focus for improvement and development.

Strengths	Weaknesses
<ul style="list-style-type: none"> • Accessible from any platform • Design interacting with user • Options panel with handy features • Meets user wants and needs 	<ul style="list-style-type: none"> • Real-time data relies on internet connection • Partially adaptive design for mobile devices • Requires accommodation/update of UIS
Opportunities	Threats
<ul style="list-style-type: none"> • Encourages to use native application • Applied modern standards of web content accessibility • Potential to develop responsive web application 	<ul style="list-style-type: none"> • Heightened interest in ‘Export to iCal’ feature may reduce visits of actual application • Certain group of users, i.e. teaching personnel, will be responsible for maintenance of up-to-date information • Possible involvement of developers from outside

Table 5.1: SWOT analysis of proposed prototype

Source: Own processing

5.2 iCalendar integration

iCalendar is a standard way of transferring calendar data between computer systems. Its files usually have file extensions ‘.ical’, ‘.ics’, ‘.ifb’ or ‘.icalendar’ with MIME (Multipurpose Internet Mail Extensions) type of ‘text/calendar’. iCalendar was originally established as a standard as RFC (Request for Comments) 2445 in 1998 by the Internet Engineering Task Force (IETF). Authors of this document are (DAWSON & STENERSON, 1998) of Lotus Notes Corporation (currently owned by IBM) and Microsoft Corporation. iCalendar standard was enhanced in 2009 as RFC 5545 and modified by (DESRUISSEAU, 2009) of Oracle Corporation. This overcame some confusions from the original standard as well as disapproved a few features that were no longer needed. RFC 5545 is nowadays deemed to be iCalendar standard and substitutes previous RFC. These days, iCalendar serves to import and synchronize

events on multiple platforms, including smartphones, computers and web applications (namely Microsoft Office 365, Apple Calendar, Google Calendar and Yahoo Calendar). (iCalendar.org, n.d.)

University Information System offers ability to ‘Export calendar to iCal’ under section ‘Personal management’ from Personal administration page (Figure 5.2). It provides downloadable file in ‘.ics’ format which can be added to Microsoft Outlook on computers, or Apple iCal / Google Calendar applications on mobile devices. Subscribed calendar displays current semester schedule of regular classes and registered exams.

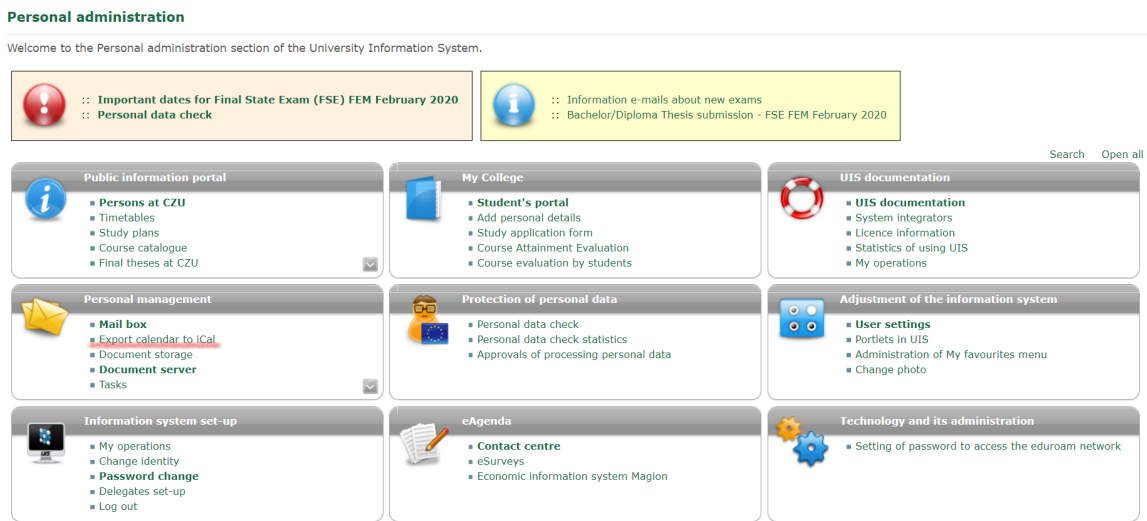


Figure 5.2: Export to iCal option

Source: University information system CZU

As it was revealed during requirements collection, users of given Personal timetable application were not aware of this opportunity. It is consequently suggested to embed iCalendar in web application under subscription feature. Besides, study blocks, days off and holidays should be included.

Chapter 6

Conclusion

The goal of this thesis was to analyse and create a prototype of an integrated timetable serving as a web application to all relevant stakeholders at Czech University of Life Sciences Prague.

To begin, there was studied essential literature to get general concept of user experience and learn primary approaches for application development. Prior to conduct of requirements analysis, their collection methods were examined and thoroughly selected. Based on collected bibliography, differences between wireframes and prototypes were identified, what is more, advantages and disadvantages of the most commonly used prototyping tools were assessed. On top of that, selection of appropriate prototyping method was made taking into account some categories such as Design Fidelity, Complexity and Speed of Use, and Aim. In the practical part, AS-IS and TO-BE states of the current electronic timetable at the university were defined by describing scenarios for each individual task. At first, illustrative set of wireframes representing key functionality was developed and tested with users. Besides, survey and brainstorming were conducted from which fundamental user requirements were collected. Bringing together feedback on created wireframes and results obtained from selected collection methods, analysis of user requirements was conducted. Based on careful study of acquired data, a new integrated electronic timetable for the university was designed as a mid-fidelity prototype, suitable for mobile and desktop devices screens.

To conclude, outcome of this work may be taken into consideration and introduced to university for applying in real practice. Students and academic staff can be encouraged to take advantage not only of current enhanced features but also newly introduced ones. Further recommendation could be to transfer integrated 'Export to iCal' option from Personal administration to Personal timetable application.

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Appendix A

Mid-fidelity prototype for mobile devices

A.1 Landscape orientation artboard

UNIVERSITY INFORMATION SYSTEM
Personal timetable
 WS 2019/2020
 Dec 9 - Dec 13, Odd week

	Mon 9	Tue 10	Wed 11	Thu 12	Fri 13
all day					
8:45 - 10:15		PEF D326 EIE3AE Web Design Lecture	PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30 - 12:00		9:35-11:50	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00		
12:15 - 13:45		RKUJ EEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45		PEF C28 EIE96E Interaction Design Lecture 12:15-14:30
14:00 - 15:30		PEF C27 EEE12E Economics of Entrepreneurship Seminar 14:00-15:30	JH010 EUE42E Fundamentals of Accounting Seminar 14:00-15:30		
15:45 - 17:15					
17:30 - 19:00					
19:15 - 20:45					

Appendix B

Mid-fidelity prototype for desktop screens


B.1 Horizontal week

UNIVERSITY INFORMATION SYSTEM
Personal timetable
WS 2019/2020

◀ Dec 9 - Dec 13, Odd week ▶

	08:45-10:15	10:30-12:00	12:15-13:45	14:00-15:30	15:45-17:15	17:30-19:00	19:15-20:45
Mon 9							
Tue 10		PEF D326 ETE3AE Web Design Lecture 9:35-11:50	RKUI EEEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF C27 EEEE12E Economics of Entrepreneurship Seminar 14:00-15:30			
Wed 11	PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45	JIH010 EUE42E Fundamentals of Accounting Seminar 14:00-15:30			
Thu 12			PEF C28 EIE96E Interaction Design Lecture 12:15-14:30				
Fri 13							


B.2 Vertical week


 UNIVERSITY INFORMATION SYSTEM
 Personal timetable
 WS 2019/2020

< Dec 9 - Dec 13, Odd week >

	Mon 9	Tue 10	Wed 11	Thu 12	Fri 13
all-day					
08:45-10:15			PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30-12:00		PEF D326 ETE3AE Web Design Lecture 9:35-11:50	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00		
12:15-13:45		RKUI EEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45		PEF C28 EIE96E Interaction Design Lecture 12:15-14:30
14:00-15:30		PEF C27 EEE12E Economics of Entrepreneurship Seminar 14:00-15:30	JIH010 EUE42E Fundamentals of Accounting Seminar 14:00-15:30		
15:45-17:15					
17:30-19:00					
19:15-20:45					

B.3 Filters


 UNIVERSITY INFORMATION SYSTEM
 Personal timetable
 WS 2019/2020

< Dec 9 - Dec 13, Odd week >

	Mon 9	Tue 10	Wed 11	Thu 12	Fri 13
all-day					
08:45-10:15			PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30-12:00		PEF D326 ETE3AE Web Design Lecture 9:35-11:50	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00		
12:15-13:45		RKUI EEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45		PEF C28 EIE96E Interaction Design Lecture 12:15-14:30
14:00-15:30		PEF C27 EEE12E Economics of Entrepreneurship Seminar 14:00-15:30	JIH010 EUE42E Fundamentals of Accounting Seminar 14:00-15:30		
15:45-17:15					
17:30-19:00					
19:15-20:45					

regular classes
 study blocks
 exams

B.4 Notifications

UNIVERSITY INFORMATION SYSTEM
Personal timetable
WS 2019/2020
Dec 9 - Dec 13, Odd week



	Mon 9	Tue 10	Wed 11	Thu 12	Fri 13
all-day					
08:45-10:15			PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30-12:00		PEF D326 ETE3AE Web Design Lecture 9:35-11:50	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00		
12:15-13:45		RKUI EEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45		PEF C28 EIE96E Interaction Design Lecture 12:15-14:30
14:00-15:30		PEF C27 EEE12E Economics of Entrepreneurship Seminar 14:00-15:30	C24 EUE42E Fundamentals of Accounting Seminar 14:00-15:30		
15:45-17:15					
17:30-19:00					
19:15-20:45					

B.5 Subscriptions




UNIVERSITY INFORMATION SYSTEM
Personal timetable
WS 2019/2020
Dec 9 - Dec 13, Odd week

	Mon 9	Tue 10	Wed 11	Thu 12	Fri 13
all-day					
08:45-10:15			PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30-12:00		PEF D326 ETE3AE Web Design Lecture 9:35-11:50	PEF C15 EIE69E UNIX Operating Systems Lecture 10:30-12:00		
12:15-13:45		RKUI EEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF C13 EIE69E UNIX Operating Systems Seminar 12:15-13:45		PEF C28 EIE96E Interaction Design Lecture 12:15-14:30
14:00-15:30		PEF C27 EEE12E Economics of Entrepreneurship Seminar 14:00-15:30	JIH010 EUE42E Fundamentals of Accounting Seminar 14:00-15:30		
15:45-17:15					
17:30-19:00					
19:15-20:45					

B.6 Study Blocks





UNIVERSITY INFORMATION SYSTEM
Personal timetable
WS 2019/2020

< Dec 2 - Dec 6, Even week >








	Mon 2	Tue 3	Wed 4	Thu 5	Fri 6
all-day					
08:45-10:15			PEF DII Economics of Entrepreneurship Study Block 9:00-12:00	PEF DII Economics of Entrepreneurship Study Block 9:00-12:00	PEF DII Economics of Entrepreneurship Study Block 9:00-12:00
10:30-12:00		PEF D326 ETE3AE Web Design Lecture 9:35-11:50			
12:15-13:45		RKUI EEEE12E Economics of Entrepreneurship Lecture 12:15-13:45	PEF DII Economics of Entrepreneurship Study Block 13:00-15:00	PEF DII Economics of Entrepreneurship Study Block 13:00-15:00	PEF DII Economics of Entrepreneurship Study Block 13:00-15:00
14:00-15:30		PEF C27 EEEE12E Economics of Entrepreneurship Seminar 14:00-15:30			
15:45-17:15					
17:30-19:00					
19:15-20:45					

B.7 Exams



UNIVERSITY INFORMATION SYSTEM
Personal timetable
WS 2019/2020

< Dec 16 - Dec 20, Even week >

	Mon 16	Tue 17	Wed 18	Thu 19	Fri 20
all-day					
08:45-10:15			PEF EIV EUE42E Fundamentals of Accounting Lecture 08:45-10:15		
10:30-12:00		PEF D326 ETE3AE Web Design examination 09:30-11:30			
12:15-13:45				RKUI EEEE12E Economics of Entrepreneurship examination 13:00-14:20	
14:00-15:30					
15:45-17:15					
17:30-19:00					
19:15-20:45					

B.8 Holidays

UNIVERSITY INFORMATION SYSTEM
Personal timetable
WS 2019/2020

Dec 23 - Dec 27, Odd week

	Mon 23	Tue 24	Wed 25	Thu 26	Fri 27
all-day		Christmas Eve	Christmas Day	St. Stephen's Day	
08:45-10:15					
10:30-12:00					
12:15-13:45					
14:00-15:30					
15:45-17:15					
17:30-19:00					
19:15-20:45					